

OPINION

by **Professor Daniela Ananieva Orozova,**
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on a Dissertation for awarding educational and scientific degree “Doctor” (Ph.D.), in
Area of Higher Education 4. *Natural Sciences, Mathematics, and Informatics*
Professional Field 4.6. *Informatics and Computer Sciences*
Doctoral program “*Informatics*”

Author: *Irina Krasimirova Krasteva*

Subject: “*Blockchain-Based Synchronization of Personal Assistants*”

Scientific supervisor: *Professor Stanimir Stoyanov, PhD., University of Plovdiv “Paisii Hilendarski”*.

1. General description of the presented materials

By order № PD-21-236 of 29.01.2024 of the Rector of Plovdiv University “Paisii Hilendarski” (PU) I was appointed as a member of the Scientific Jury to provide the procedure for the defense of a dissertation titled “Blockchain-Based Synchronization of Personal Assistants” for awarding the educational and scientific degree “Doctor” in the Area of higher education “4. Natural Sciences, Mathematics, and Informatics“, Professional field “4.6. Informatics and Computer Sciences“, the doctoral program “Informatics“. The author of the dissertation is Irina Krasimirova Krasteva – a Ph.D. student in full-time education at the department “Computer systems” of the Faculty of Mathematics and Informatics at the University of Plovdiv “Paisii Hilendarski“, with scientific supervisor: Prof. Stanimir Stoyanov, PhD.

The set of materials presented by Irina Krasteva is in accordance with Art. 36 (1) of the Rules for the Development of the Academic Staff of University of Plovdiv “Paisii Hilendarski”, and it includes the following documents: Application to the Rector for opening a procedure for the defense of the dissertation; CV in European format; Protocol from the Department Council, related to reporting on the readiness for opening the procedure and the preliminary discussion of the dissertation; Abstract in Bulgarian and English; Declaration of originality and authenticity of the attached documents; Information on compliance with the minimum national requirements; List of scientific publications on the topic of the dissertation; Dissertation thesis; Opinion of the scientific supervisor on the readiness of a dissertation work for defense before a scientific jury; Official note

for participation in projects; Copies of scientific publications on the topic of the dissertation. The Ph.D. student has attached 4 publications on the topic of the dissertation.

2. Brief biographical data about the Ph.D. student

The Ph.D. student Irina Krasteva graduated from the “Paisii Hilendarski“ University of Plovdiv in 2010, majoring in "Informatics" and a master’s degree “Financial Management” at the University of Plovdiv in 2015. The Ph.D. student has teaching experience as an honorary assistant since 2018 at the Faculty of Mathematics and Informatics, at the University of Plovdiv, department “Computer systems”. Irina Krasteva has teamwork skills and good communication skills.

3. Relevance of the topic and expediency of the set goals and objectives

The work is aimed at combining intelligent personal assistants with Blockchain technologies, which increases the level of credibility in interactive communication between intelligent components in a multi-agent system. The aim of the research is clearly defined (on page 8 of the dissertation) “to analyze and conduct experiments on the integration of intelligent personal assistants with blockchain technology”. The following sub-goals correspond to the goal:

- Development and testing of an "Electronic School Diary" model, built on the basis of synchronization between intelligent agents and the use of blockchain technologies within the framework of adaptation of the reference architecture in the field of secondary education;
- Development and testing of a model for the application of the technology in the adaptation of the ViPS architecture in intelligent agriculture conducting experiments for verification of the constructed NCS and proposing methods for its optimization.

A step-by-step approach is used in the realization of the sub-goals.

4. Knowledge of the problem

The analysis of the possibilities of using Blockchain technologies in synchronization with agents in a multi-agent cyber-physical system, made in the first chapter, the large number of studied literature sources (150 sources), as well as the conclusion gives me the reason to conclude that the Ph.D. student has exhaustive knowledge of the subject of the dissertation. The realization of the dissertation requires in-depth scientific knowledge and high scientific and practical qualification, which its author undoubtedly possesses.

5. Research methodology

A methodologically correct approach for conducting the research has been chosen, where the sub-goals and tasks correspond to the goal of the dissertation and the same is a good reference point for conducting the research. The significance of the results obtained by the Ph.D. student is expressed in their applicability. The created prototypes and conducted experiments prove the possibility of successful integration of Blockchain technologies in multi-agent systems.

6. Characteristics and evaluation of the dissertation

The dissertation of Irina Krasteva “Blockchain-Based Synchronization of Personal Assistants” contains 139 pages. The structure of the dissertation follows the described stages of the scientific research and consists of an introduction, four chapters and a conclusion, a list of the author’s publications on the topic of the dissertation, a declaration of originality, a list of references. The bibliography includes 150 sources, 7 of which are in Bulgarian. The text contains 35 figures.

In Chapter 1 *“Motivation and state of the research problem”*, the main features and challenges of Blockchain technology are presented and the features of cyber-physical and cyber-physical-social systems are considered. cyber-physical systems (CPS), and cyber-physical social systems (CPSS). In Chapter 2 *“Application of blockchain technologies in a multi-agent system and adaptation of ViPS in education”* the software architecture is presented and the educational multi-agent environment for BLISS Middle School is modeled. Blockchain-based synchronization with personal assistants in the construction of the electronic diary is presented. Chapter 3 *“Application of blockchain technologies in a multi-agent system and adaptation of ViPS in agriculture”* presents the application of the considered concept in creating a system for intelligent agriculture, realizing: a validator of new seed samples in the national gene bank and a store for the sale or exchange of seed samples. In Chapter 4. *“Conceptual models and future plans”* models created in the development of systems in the field of the supply chain of agricultural production and tourism are presented. Prospects for the future development of the topic have been formulated. The **Conclusion** summarizes the obtained results from the conducted research.

7. Contributions and significance of development for science and practice

I accept the main results and contributions indicated by the Ph.D. student on page 112 of the dissertation. The contributions have a scientifically applied, and applied character:

- A general concept has been created for blockchain synchronization of information and interaction with personal assistants within a cyber-physical multi-agent system.
- Concrete models have been created for the application of the developed concept in the adaptation of the reference ViPS architecture in the fields of education and intelligent agriculture.
- Prototypes were created to test the application of the developed models.

8. Assessment of dissertation publications

The main results of the dissertation research are presented in 4 publications in peer-reviewed editions. **The analysis of the scientific works shows the following:**

- **2 publications are in specialized journals;**
- **2 publications are reports from international scientific conferences;**
- **2 publications are indexed in the scientific database Scopus,** with which has 36 points and satisfies the minimum national requirements of the Regulations for the Implementation of the Law on the Development of the Academic Staff of the Republic of Bulgaria;
- **3 publications are in English;**
- **publications are co-authored.**

A declaration of the originality of the obtained results and contributions is presented.

The Ph.D. student participated in the team of project KP-06H36/2 from 13.12.2019, Fundamental scientific research from 2019 to 2022 to the Scientific Research Fund, BG PLANTNET "Creation of a national information network gene bank - plant genetic resources" - financed by "Scientific Research" fund at the Ministry of Education and Science.

9. Personal participation of the Ph.D. student

The Ph.D. student has shown in their research in-depth knowledge in the field and ability for independent scientific research. I accept that the Ph.D. student's contribution to the presented collective publications is comparable and commensurate to that of the other authors.

10. Abstract

The abstracts in Bulgarian and English meet the volume and content of the requirements for accurate, complete, and concise coverage of the dissertation.

11. Personal impressions and recommendations

I know Irina Krasteva from her participation in scientific forums and expert groups in procedures for program accreditation of Higher Schools in the country, as well as from her presented materials. My personal impressions are entirely positive.

I recommend Irina Krasteva to continue and expand research related to the application of Blockchain technology. The field of research is wide and fertile.

CONCLUSION

The dissertation contains scientifically applied and applied results, which represent an original contribution to science and meet the requirements of the Law for Development of the Academic Staff in the Republic of Bulgaria (LDASRB), The Regulations for application of LDASRB, and the relevant Regulations of the University of Plovdiv “Paisii Hilendarski”. The submitted materials and dissertation results fully comply with the minimum national requirements in the Regulations for the Implementation of LDASRB.

Due to the above, I confidently give my *positive assessment* of the research presented by the dissertation reviewed above, abstract, results, and contributions, and *I propose to the Honorable Scientific Jury to award the educational and scientific degree “Doctor” to Irina Krasimirova Krasteva* in the Area of higher education: **4. Natural sciences, mathematics and informatics**, Professional field **4.6. Informatics and computer sciences**, Doctoral program **Informatics**.

12.02.2024

Opinion prepared by:
(Prof. Daniela Orozova)